Influence of Density on Production Traits of Laying Hens

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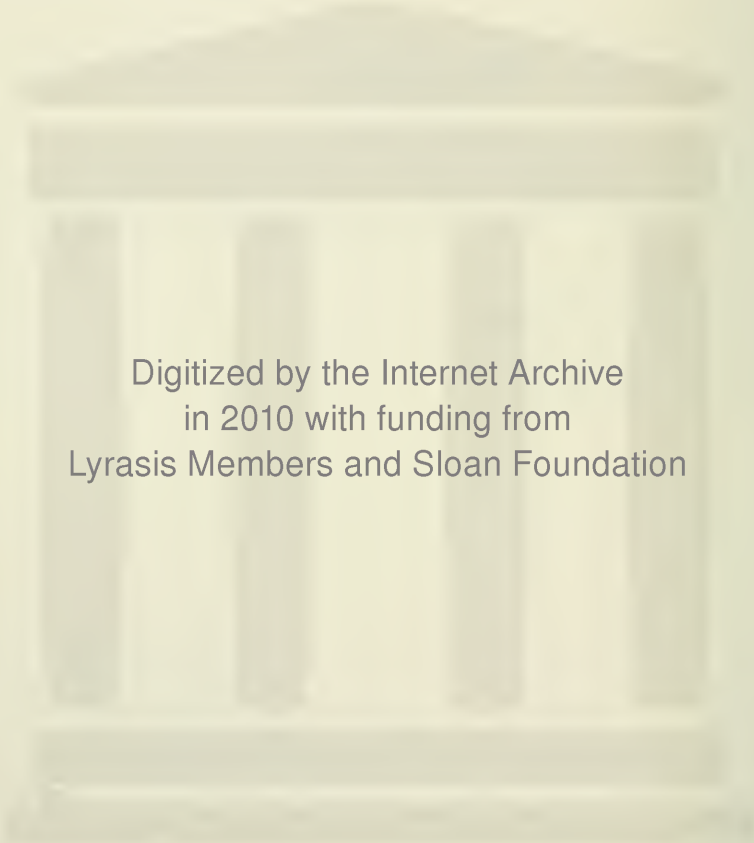

Influence of Density on Production Traits of Laying Hens

H. M. Hyre, J. R. Johnson, and M. R. McClung

In recent years poultrymen have been allowing less space for laying hens than once was the custom. It is now evident that hens can perform satisfactorily under what seems to be crowded conditions. Floor management will be considered only in this investigation. It is well recognized that with a management system of less than 2 sq. ft. of floor space per bird at least two-thirds of the floor space should be covered with slats or wire. The hens must be debeaked and the house should be fan-ventilated. The number of birds to a given floor space is referred to as hen density. Increased density will reduce housing costs, which could result in greater profits. An attempt was made here to investigate the results from hens that were subjected to various floor densities.

EXPERIMENTAL PROCEDURES

A mechanically ventilated building, 29′ x 63′, which was well insulated, provided the housing space for this study. The building was divided into four equal pens, making available 456 sq. ft. of floor space in each pen. Three-fourths of the floor space in each pen was covered with wire and slats, and the remainder was covered with litter. The number of birds housed per pen was 608, 456, 365, and 304, allowing ¾, 1, 1¼ and 1½ sq. ft. of floor space per bird, respectively. All feeders and water troughs were placed on the slats and wire. The number of feeders, water troughs, and nests were identical per bird for each of the pens. All birds received 14 hours of light daily.

In addition to these four pens, six other pens were used without wires and slats. The hen density was not as great here because the feeders and waterers were placed on the floor, which was covered with litter, and the building was not fan-ventilated. Each pen had 200 sq. ft. of floor space and three of them had 133, 100, and 80 birds each, allowing 1½, 2, and 2½ sq. ft. of floor space per bird. These three pens were replicated. This phase of the project will be discussed later.

White Leghorn strain cross chicks were hatched on August 4 and placed in the laying quarters on December 22, when the pullets were 140 days old. All records were started on January 1, when the birds were 150 days old. Egg production records were recorded daily and mortality was recorded on the days that birds died. All eggs from each pen were weighed bi-monthly and were classified as extra large, large, medium, small, or peewees. Interior egg quality and shell quality were measured monthly by determining the Haugh units and specific gravity of the eggs through random sample of eggs consisting of 15 per cent of the number of birds housed per pen. Body weights were recorded at 140, 250, 365, and 500 days of age. The study terminated when the birds were 500 days of age.

RESULTS AND DISCUSSION

Table 1 shows the per cent of egg production and it may be noted that the hens in pen 1 (least amount of floor space per bird) had an annual egg production of only two percentage points less than the hens in pen 4 (twice as much floor space). The lowest egg production was in pen 2 (1 sq. ft. of floor space per bird). The production in pen 3, which provided 1¼ sq. ft. of floor space per bird, was essentially the same as that in pen 4 with ¼ sq. ft. floor space more per bird. The number of eggs produced per bird to 500 days of age in pens 1, 2, 3, and 4 was 239,

TABLE 1
Per Cent Egg Production—Hen Housed Basis

Floor Space/Bird	¾ sq. ft.	1 sq. ft.	1¼ sq. ft.	1½ sq. ft.
Month	1	2	3	4
			Pen No.	
January	29.92	31.49	32.04	32.77
February	88.23	89.13	91.59	90.24
March	83.89	85.14	86.65	87.30
April	81.37	81.03	85.47	83.58
May	79.73	76.89	79.19	81.31
June	75.57	71.41	77.83	77.16
July	72.52	61.13	74.07	75.18
August	70.58	66.05	71.51	72.39
September	65.27	61.88	65.89	66.12
October	55.48	55.69	56.80	59.08
November	55.60	51.92	57.07	58.60
December	53.39	50.64	55.49	56.66
$\bar{X}$	68.01	66.27	69.81	70.38

233, 245, and 247, respectively. The difference in egg production between the high and low pens was only 14 eggs, even though the high pen provided 50 per cent more space per bird.

Since the differences in egg production of the four pens were small and production was not in sequence with the space allotted, it would seem logical to assume that the difference in floor space allowed in this study did not influence egg production.

Table 2 gives the per cent mortality for the laying year. None of these mortality percentages would be considered excessive and the differences between pens are not significant. Since these differences were small and they did not follow in order with the floor space allotted, it would seem unlikely that mortality was influenced by this treatment.

Tables 3 and 4 present information relative to egg weight, and these data were collected and recorded in two different ways. The information in Table 3 was gathered at two-week intervals by separating into weight grades all the eggs that were produced for one day. Table 4 shows the average weight in grams per egg for the various pens. To get this data random samples of eggs consisting of 15 per cent of the number of birds housed per pen were used. While the data in these two tables show some variations in egg weights between pens, it does not appear likely that these differences are due to floor space per bird.

The shell strength of the eggs was determined by the specific gravity method using a series of salt solutions. Specific gravity of

TABLE 2
Per Cent Mortality

Month	Sq. Ft. of Floor Space/Bird			
	¾	1	1¼	1½
January	.66	.00	.00	.00
February	.99	.66	.00	.66
March	1.34	.66	.27	.33
April	.51	3.11	.55	.00
May	.86	.69	1.38	1.99
June	.34	.00	.28	.34
July	.52	.46	.14	.68
August	.52	1.16	.28	.34
September	.87	.94	.29	1.37
October	.53	.95	.00	1.07
November	.35	.72	.00	.70
December	.00	.24	.00	.35
Total for Year	7.07	9.21	4.38	7.57

the solutions ranged from 1.062 to 1.098 with intervals of .004 between salt solutions. Specific gravity scores ranged from 1 to 10 with 1 equaling 1.062 specific gravity. The specific gravity score indicates shell thickness or shell strength, and the higher the score the greater the shell strength. An egg with a score of 5 or better would have satisfactory shell strength.

Table 5 shows the specific gravity of the eggs for the four pens. These data were obtained from a random sample of eggs taken from each pen monthly. It may be noted that there is very

TABLE 3
Per Cent of Large and Extra Large Eggs Produced

Month	Sq. Ft. of Floor Space/Bird			
	¾	1	1¼	1½
January	2.73	2.78	1.15	1.32
February	16.82	20.15	17.25	20.25
March	35.79	40.18	35.91	42.77
April	56.15	56.62	57.77	58.33
May	66.85	70.76	68.06	74.15
June	70.32	75.95	75.91	73.52
July	74.97	79.52	79.00	79.21
August	78.48	79.86	81.26	82.13
September	83.83	87.06	81.03	84.00
October	85.71	87.81	86.11	92.75
November	93.44	95.76	96.77	94.86
Average	62.52	64.66	63.47	66.10

TABLE 4
Egg Weights—Grams

Month	Sq. Ft. of Floor Space/Bird			
	¾	1	1¼	1½
January	43.20	44.60	44.50	44.20
February	53.98	54.06	54.66	55.20
March	55.57	55.26	55.96	55.41
April	56.43	57.44	57.21	57.56
May	58.34	59.62	58.14	59.33
June	59.56	59.98	58.84	59.65
August	59.70	60.60	63.10	60.80
September	59.70	61.20	58.10	58.80
October	62.90	62.20	62.80	62.90
December	64.00	63.10	63.50	65.90
$\bar{X}$	57.34	57.80	57.68	57.98

TABLE 5
Specific Gravity Score of Eggs

Month	Sq. Ft. of Floor Space/Bird			
	¾	1	1¼	1½
January	8.21	8.59	8.41	8.43
February	7.20	7.06	7.43	7.43
March	6.46	7.19	7.91	7.15
April	6.87	6.68	6.36	6.72
May	6.46	6.19	5.93	5.82
June	5.50	5.50	5.90	5.60
August	4.40	4.30	4.30	4.70
September	4.70	4.60	5.80	6.10
October	5.20	4.90	5.60	4.80
December	4.90	4.80	5.20	4.90
$\bar{X}$	5.99	5.98	6.28	6.17

little difference in the average yearly specific gravity between pens, and it would appear that space per bird had little or no effect on this trait.

The Haugh units of the egg produced by the birds in the various pens are recorded in Table 6. Haugh Unit is a term used to express the albumen quality of eggs and is determined from the height of the albumen and the weight of the eggs. U. S. grade A eggs must have from 60 to 72 Haugh units and grade AA eggs must have 72 Haugh units or more. The information given in Table 6 was computed from random samples of eggs taken from

TABLE 6
Haugh Units

Month	Sq. Ft. of Floor Space/Bird			
	¾	1	1¼	1½
January	93.3	92.2	93.2	97.1
February	89.2	94.2	92.6	91.8
March	87.2	88.9	81.3	85.4
April	82.2	83.9	81.9	84.8
May	77.3	79.0	77.8	79.0
June	74.4	73.7	79.2	82.3
August	81.1	81.6	72.1	74.0
September	75.6	72.6	71.0	69.6
October	72.5	75.0	72.1	74.2
December	70.8	73.2	71.2	74.9
$\bar{X}$	80.36	81.43	79.24	81.31

the various pens, and these data would indicate that the hen densities studied here did not influence the interior quality of the eggs produced.

Table 7 gives the days of age of the pullets to the first egg produced, 50 per cent production, and peak production for the various pens. These traits apparently were not influenced by hen density.

The other part of the study which involved six pens, three pens replicated, revealed similar results relative to hen density as the four pens already discussed. This phase of the investigation started on January 1 and was terminated on August 16, when the birds were 378 days old. These birds were from the same strain and same hatch as those in the other phase of the study.

Table 8 shows the per cent egg production for the various months and the average for the laying period by pens after the replicates have been combined. The variation here is only one percentage point between pens. It will be noted that the average

TABLE 7

Floor Space/Bird Sq. Ft.	Days of Age to First Egg	Days of Age to 50 Per Cent Production	Peak	Production
			Days	*Per Cent*
¾	154	173	203	91.94
1	153	172	197	93.20
1¼	153	172	193	98.90
1½	155	171	193	94.74

TABLE 8

Per Cent Egg Production—Hen Housed Basis
Combined Replicates

Month	Sq. Ft. of Floor Space/Bird 1½	2	2½
January	34	35	34
February	89	88	90
March	87	88	89
April	85	85	86
May	81	82	82
June	78	76	80
July	71	72	72
August	63	66	64
$\overline{X}$	74	74	75

per cent production is high, but it must be remembered that the laying period reported here includes only the first 7½ months. It has been concluded from these data that hen density in this investigation did not influence egg production.

Feed efficiency for the combined replicates for the various floor space allotted is given in Table 9. These differences are not large and do not occur in accordance with the floor space provided per bird. Therefore, it would seem doubtful that they were due to this treatment. Feed efficiency refers to the pounds of feed required to produce a dozen eggs.

Table 10 shows hen mortality and it is important that the treatment did not influence this trait.

TABLE 9
Feed Efficiency of Combined Replicates

Month	Sq. Ft. of Floor Space/Bird		
	1½	2	2½
January	4.90	5.34	4.80
February	4.90	5.34	4.80
March	3.32	3.73	3.53
April	3.72	3.36	3.67
May	3.92	3.85	3.66
June	3.95	4.26	3.90
July	3.82	3.94	3.66
August	4.26	3.70	3.72
$\overline{X}$	3.99	4.03	3.86

TABLE 10
Per Cent Mortality of Combined Replicates

Month	Sq. Ft. of Floor Space/Bird		
	1½	2	2½
January	0.00	0.00	.62
February	0.00	1.00	0.00
March	.38	.51	.64
April	0.00	0.00	.64
May	1.12	.50	.63
June	0.00	0.00	0.00
July	.76	1.02	1.26
August	.38	0.00	0.00
Per Cent for Laying Period	2.63	3.00	3.75

The per cent of eggs that were large and extra large is given in Table 11. There are some differences between various floor space allotted. However, it does not appear that these differences are caused by the hen density, since the variations in egg weight do not show any relationship to floor space.

Table 12 gives the egg weight in grams. These data do not indicate that there are any differences for this trait between pens.

The data given in Table 13 do not show that the treatment had any effect on shell strength as the specific gravity of the eggs is similar for all pens. A similar condition exists for interior egg

TABLE 11
Per Cent of Large and Extra Large Eggs Produced
Pen Replicates

Month	Sq. Ft. of Floor Space/Bird		
	1½	2	2½
January	3.5	2.9	7.4
February	18.4	15.7	16.0
March	39.3	44.1	37.1
April	54.7	61.6	50.0
May	63.9	65.0	62.8
June	71.6	76.3	70.1
July	72.1	79.5	68.5
August	76.8	78.0	74.5
$\bar{X}$	51.9	54.6	49.2

TABLE 12
Egg Weights—Grams
Combined Replicates

Month	Sq. Ft. of Floor Space/Bird			
	1½	2	2½	$\bar{X}$ of All Pens
January	46.1	48.0	45.4	46.5
February	53.2	52.8	53.9	53.2
March	56.3	55.6	54.8	55.2
April	57.3	57.4	56.4	57.1
May	59.2	59.2	57.2	58.7
June	58.9	60.4	58.1	52.2
August	60.7	60.8	59.9	60.5
$\bar{X}$	56.2	56.4	55.2	56.0

TABLE 13
Specific Gravity Score of Eggs of Combined Replicates

Month	Sq. Ft. of Floor Space/Bird		
	1½	2	2½
January	9.34	8.86	9.12
February	7.04	6.92	7.16
March	6.91	6.98	6.84
April	6.42	6.50	6.84
May	6.59	6.35	6.22
June	6.39	5.65	5.75
August	5.45	5.30	5.50
$\overline{X}$	6.8	6.6	6.8

TABLE 14
Haugh Units for Egg Quality for Combined Replicates

Month	Sq. Ft. of Floor Space/Bird		
	1½	2	2½
January	94.2	96.0	95.2
February	86.8	85.5	84.7
March	87.6	85.8	86.4
April	86.0	87.9	85.6
May	78.9	80.3	80.3
June	75.4	76.6	79.4
August	77.2	77.9	78.5
$\overline{X}$	83.7	84.2	84.3

quality as may be noted in Table 14. Here the variations in Haugh units between pens do not show any material differences.

Days of age to first egg, to 50 per cent production, and to peak production are all shown in Table 15. These data show that hen density failed to influence the time that these periods of production occurred.

ECONOMIC ASPECTS OF THE STUDY

Data collected in this investigation failed to reveal any influence from hen density on egg production traits, such as egg number, egg size, hen mortality, interior egg quality, and shell quality. There is a difference, however, in the number of eggs produced in each pen, and this would influence the housing costs per dozen of eggs produced. An increased number of eggs from a given space would reduce housing costs per dozen.

TABLE 15

Floor Space/Bird Sq. Ft.	Days of Age to First Egg	Days of Age to 50 Per Cent Production	Peak Production	Peak Production
			Days	*Per Cent*
1½	150	172	202	94
2	150	171	201	94
2½	151	171	195	95

Information from pens 1, 2, 3, and 4 revealed that as space per bird increased the number of eggs per hen increased only slightly. Table 17 shows the number of eggs produced per bird as well as the number produced in each pen. It may be noted that pen 1 had 100 per cent more hens than pen 4 and produced 94 per cent more eggs. Even though some more equipment is required as hen numbers increase, the housing and equipment costs per dozen of eggs decrease as number of eggs per pen increase. An estimate from the results of this work indicates that housing and equipment costs per dozen of eggs produced was .7 of a cent in pen 1 and .9 of a cent in pen 4. Assuming that returns above all costs in pen 4 were 5 cents per dozen then the returns above all costs in pen 1 would logically be 5.2 cents per dozen. If these conditions can be accepted, then the returns above costs from

TABLE 16
Number of Dozen Eggs Produced

Floor Space/Bird Sq. Ft.	Dozens
1½	3,726 dozen
2	3,142 dozen
2½	2,280 dozen

TABLE 17
Egg Production Per Pen

Floor Space/Bird Sq. Ft.	Hens/Pen	Eggs/Hen	No. Eggs/Pen	Doz. Eggs/Pen
¾	608	239	145,312	12,109
1	456	233	106,248	8,854
1¼	365	245	89,425	7,452
1½	304	247	75,088	6,257

pen 1 would be $.052 x 12,109 or $629.67 while the returns from pen 4 would be $.05 x 6,257 or $312.85.

SUMMARY AND CONCLUSIONS

Hen density was studied on slat floors and litter floors. Data regarding egg production, egg size, mortality, feed conversion, interior egg quality and shell quality were collected. Hens on the slatted floors were allotted ¾, 1, 1¼, and 1½ sq. ft. of floor space per bird. Hens on the litter floors were given 1½, 2 and 2½ sq. ft. of floor space per bird. There were some slight differences in the egg production traits between pens, but they were not considered great enough to be of economic importance. The data collected in this study indicate that it would be more profitable to house production hens at high density.